

EXHIBIT 3

Inside Project Loon: Google's internet in the sky is almost open for business

By Ben Popper on March 2, 2015 11:34 am

"Good news," says Katelyn Jabbari, Google X's communications chief. "It's about to explode."

We're several hundred feet in the air, inching our way along a wooden walkway tucked high into the rafters of the massive hangar at Moffett Federal Airfield, where Google's most outlandish and secretive division has been testing new prototypes for Project Loon. Below us, a pair of huge balloons sway gently on their tethers. Engineers are racing around them like ants.

Loon is being built with the audacious goal of beaming internet access down to the most remote parts of the planet, using specially equipped balloons that kiss the upper edges of Earth's atmosphere. Today, the team is running an inflation test that will measure the pressure that the giant white spheres can handle before popping. The pressure hits 1000 pascal. "It usually doesn't last much longer," says Jabbari.

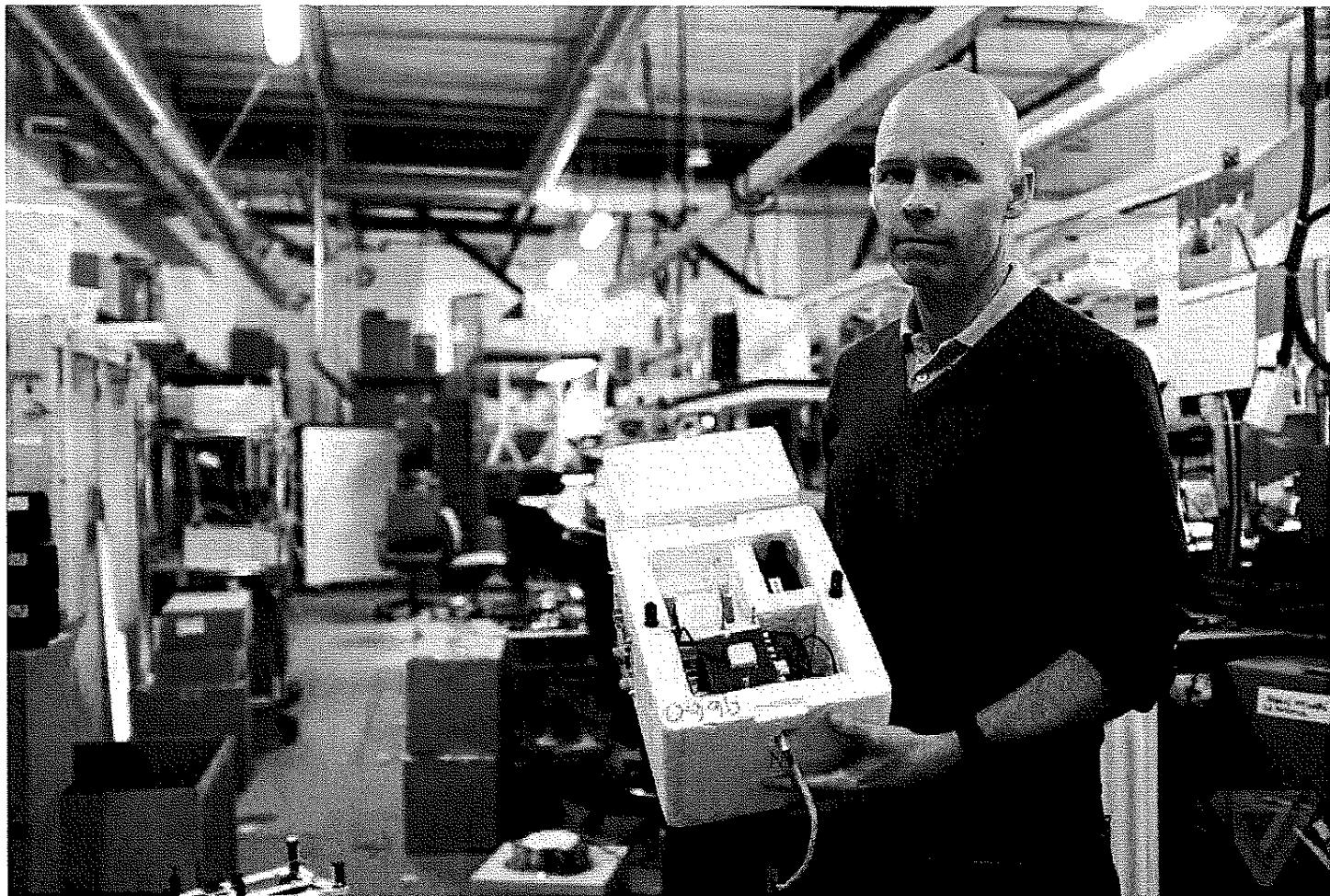
The ground crew radios up another report. "We're at 1,100 now," she continues. "I don't think it's ever been this high without ripping before." A bulge emerges on the far side of the balloon, and several engineers scurry over with a mass spectrometer, searching for tiny ruptures in the fabric, invisible to the naked eye, that might be leaking. "Okay, we're at 1,200; that is a new record," she says a few minutes later. "I don't really know what's going to happen now."

That's a good metaphor for Project Loon as a whole. As it moves past the technical hurdles of floating the internet miles above the planet, Loon is poised to enter uncharted territory: building an actual business.

BALLOONS ARE NOW STAYING ALOFT FOR SIX MONTHS

This morning, in front of top mobile executives from around the world, Google's Sundar Pichai laid out a renewed pitch for Project Loon. "[It] started about four years ago as an experimental idea. When you think about it, it sounds a bit crazy," Pichai admitted. But they've made "huge progress," he says, dramatically increasing their data speeds and coverage area. The early models last only a few days; the goal for commercial viability was to have them floating for three months. "Today we are excited to announce most of our balloons stay up for as long as six months," says Pichai.

The newest record was a balloon that lasted 187 days in the air, circumnavigating the globe nine times, passing over more than a dozen countries on four continents along the way. As Google Glass undergoes a reset, and driverless cars remain years away from commercial viability, Loon looks increasingly like the poster child for bringing a disruptive new technology out of Google's labs and into the real world. After successful tests with several telcos, Loon is now in the process of working toward commercial deals with several network operators around the globe. "We think the model is really beginning to work, and we have started large-scale testing," said Pichai. "We'll be working with carrier partners around the world so they can build their services on top of our backbone."



Loon was born out of a long-standing fascination that Google's founders, Larry Page and Sergey Brin, had with high-altitude balloons. "Either we could take something they hadn't thought about, present it to them, and get them excited," explains Google X chief Astro Teller, "or we could take something they were already excited about, but no one really knew how to do and make it work."

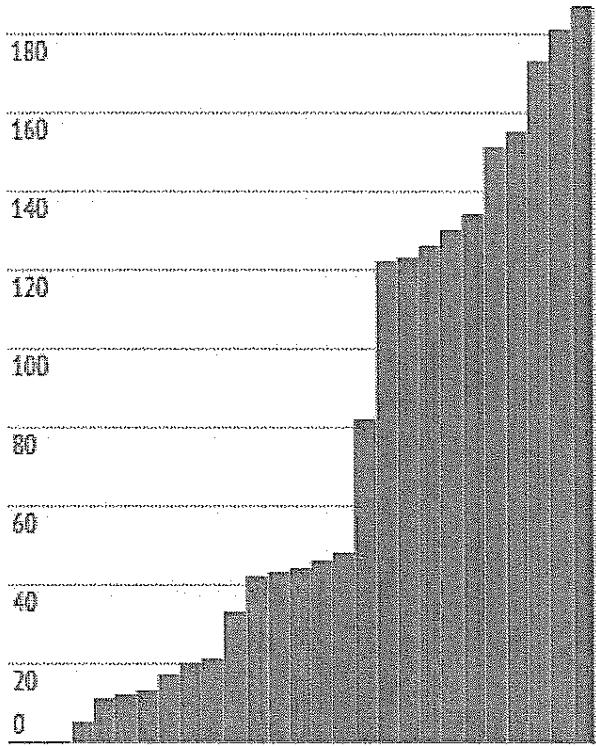
The man tasked with "making it work" is Mike Cassidy, a serial entrepreneur with a nose for the next big thing. I met up with him in a crowded lab on Google's main campus, a 15-minute drive from the towering Moffett hangar where engineers were stressing Loon's translucent shells to their limits.

A VERY PARTICULAR SET OF SKILLS

On his way to Google, Cassidy founded and sold four startups, including the search engine DirectHit, which AskJeeves bought for \$532 million just 500 days after he launched it. Cassidy ended up at Google after it acquired his travel search startup, Ruba, in 2010. He spent some time working on Google's core search product, but in 2012, Teller came calling. He needed someone with entrepreneurial experience — but Cassidy also possessed a unique set of skills which had been dormant for a while.

"I actually got my bachelor's and master's from MIT in aerospace engineering," Cassidy explains. Before jumping into the software startup game, he "designed communication satellites for a while," where he saw firsthand how painstakingly slow the development process could be. "It would take three to four years to build a satellite and a year waiting for it to launch. If it was on station for 10 to 12 years, at some point, you're using technology that is five, seven, even 10 years old."

At Teller's Google X, things move a little faster. The initial step in any of the team's projects is simple, Cassidy explains: "We try to prove that it can't work. So the first thing we did was take a router and flew it on a weather balloon up to 10 kilometers to see if we could still get a signal. That part worked."



Between March 2014 and January of this year, Loons set a series of duration records, topping out above 180 days.

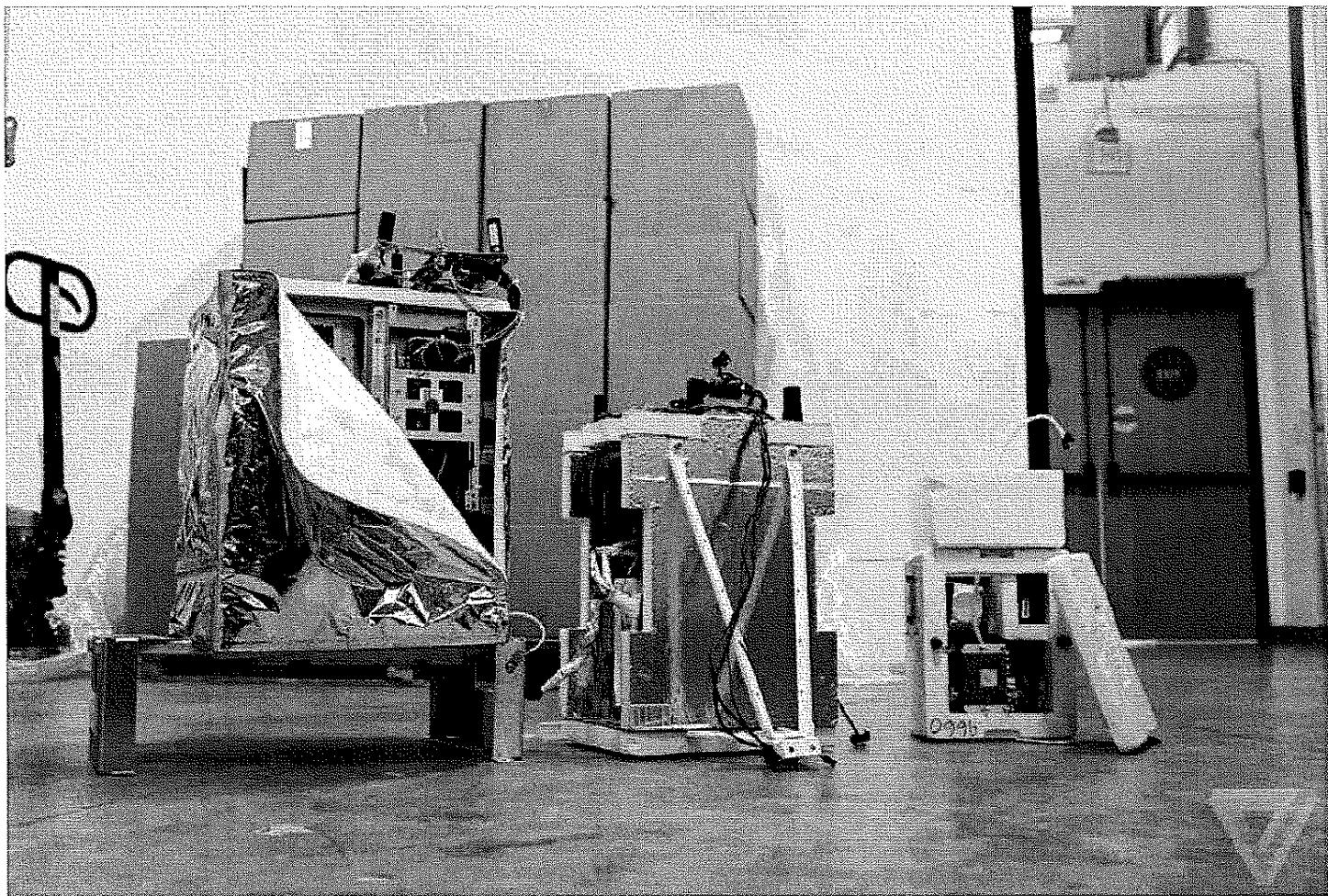
When you imagine a sensitive computer system that will be subjected to the harsh conditions of the stratosphere, you probably don't picture it inside a \$2 box meant for a picnic. But in the fast and dirty ethos of X Labs, the simplest solution is often the best one — and so it was that the flight controller on early balloons was jammed into a styrofoam beer cooler and set to the edge of outer space. The team keeps that original unit around as a memento.

Since then, the payload has evolved into a modular aluminum rig wrapped in a metal-mylar blanket that insulates it from temperature changes and high-intensity ultraviolet rays. It's suspended below two solar panels that collect all the energy used to power its onboard systems. The entire payload below the balloon looks very much like a miniature satellite, but takes a fraction of the time and money to produce. Google won't divulge the exact cost, except to say each balloon costs "tens of thousands of dollars."

"Communication satellites are typically pretty expensive, hundreds of millions to build and a hundred million plus to launch," says Cassidy. "Whereas the balloons are an order of magnitude or two cheaper to operate on a daily basis, even for a global network."

Loon is always aiming to extend the lifespan of its flights, but in some ways, a short ride can be an advantage. "With balloons you're only four to five months away from having a

fresh balloon," Cassidy explains. "New technologies come, new compression algorithms, the electronics can be updated, so you have a pretty fresh fleet in the air at any time."



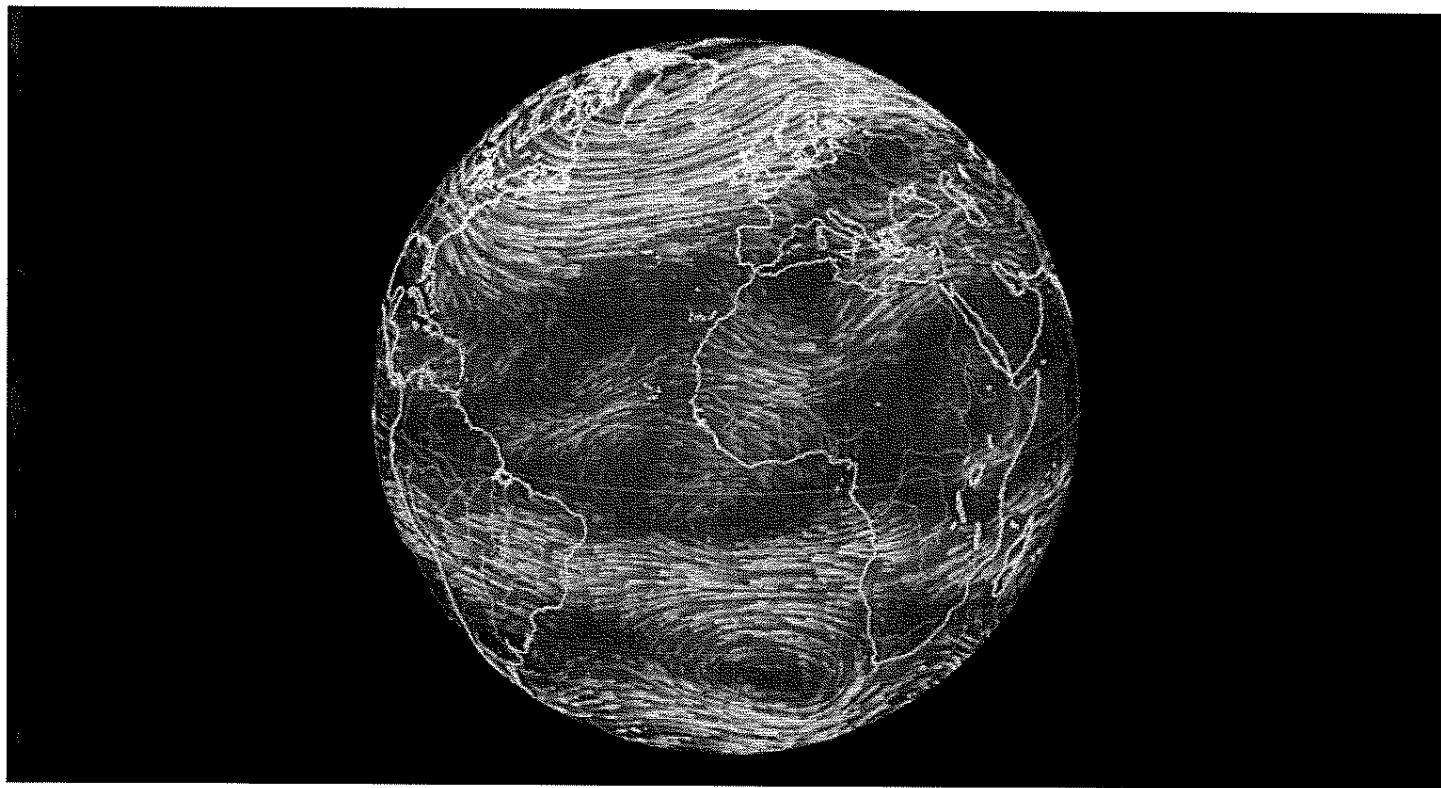
From right to left, the evolution of Loon's high-tech payload, starting with a styrofoam picnic cooler.

Google isn't the only company born on the internet trying to make the transition to internet access provider: Facebook is charting a similar course, launching a number of initiatives (including drones) with the goal of flooding the world with internet service. That raises a troubling question: as the world's internet superpowers use their dominant positions to extend access to the developing world, will they be ensuring that people can reach the web, or just a white-listed portion of it? In India, Facebook's Internet.org partnership — which is often styled as an altruistic endeavor — doesn't include free access to Twitter, Google, or any other big name company that Facebook might view as a competitor. It's essentially the antithesis of net neutrality.

CAN THE WORLD'S GIANT INTERNET SERVICES BE TRUSTED TO PROVIDE UNFETTERED INTERNET ACCESS?

When I asked Cassidy if the internet enabled by Loon would be restricted in any way, or if Google would favor its own services, he seemed surprised by the question. "I honestly don't know. No, it's the internet, whatever you get on the internet. It opens a Chrome browser and whatever you've set as your homepage."

Teller confirmed Loon's internet would be agnostic — you don't even have to use Chrome — and that it could still benefit Google in the process. "We believe that there is plenty of goodness and plenty of financial benefit in the long run for Google," he told me. "We don't need there to be some other goal."



The balloons ride global wind currents like rivers, climbing and sinking to find the right flow. (EarthWindMap)

You can't just launch a bunch of balloons and connect the world, though: right now, Project Loon flies primarily over the southern hemisphere. That's partially a question of where its services are most needed. Compared to the northern hemisphere, the southern half of the planet is far less densely populated, full of remote areas where broadband internet is less likely to reach. These countries also provide a more welcoming regulatory atmosphere. "The southern hemisphere is pretty easy to overfly in

terms of air traffic control," says Johan Mathe, a Frenchman in charge of designing Loon's navigation. "That's one of the places where there is the least hand off to do."

EACH LOON IS REALLY TWO BALLOONS IN ONE

Mathe strolls up to a whiteboard inside of one of the innumerable windowless conference room that dot the Googleplex. To navigate, he explains, the Loons only move up and down, surfing through different altitudes to find wind currents that will carry them where they want to go. Each Loon is actually two balloons, one inside the other. The outer balloon is filled with helium that lifts it to its float altitude, while the inner balloon takes on air to descend or vents it to rise, like a boat using water as ballast.

Using massive data sets from the National Oceanic and Atmospheric Administration (NOAA), Google's algorithms try to decide which currents they should ride to pass over coverage areas. It's a big data exercise that perfectly fits the company's core capabilities. Mathe draws a rainbow on the board, a vast array of possible trajectories that each balloon will take based on the wind.

"We only get 15 days of weather data, and after five or six days, the quality degrades. We cannot foresee the future very precisely," explains Mathe. The algorithms he crafts try to begin by hitting a broad target. "As we get closer, we kick in more frequent altitude changes." He shows a recent flight that launched from New Zealand, aiming to overfly a small town in Chile. It travels smoothly for a while, then begins to zigzag its way closer to the destination. "We can observe this kind of tacking pattern, as sailors would do." The balloon passed within 500 meters (about 1,640 feet) of the village and successfully connected to a device on the ground.

THE WINDS CAN BE UNPREDICTABLE

The flows aren't always that predictable. During a live demo in front of Brazil's minister of communications, a balloon drifted directly away from the village it was supposed to connect. Another one took out electricity to homes in a Washington town when it missed its landing site and came to rest on a power line. "Usually when you fly in the southern hemisphere, you stay there. At least that's what we thought until we had a flight change hemispheres," says Mathe with a chuckle. "We were like, 'What!' We thought that wasn't possible. So that was pretty fun."

As the balloons crisscross the globe, educating governments about what Loon is and how it works will be critical to the project's success. Countries like China, already

outright hostile to Google's web services, may have little interest in allowing the search giant to beam internet access to its citizens, something that would make it difficult to reach a neighbor like India as well. That could put a huge swathe of the world's unconnected consumers out of Loon's reach. The company declined to comment on when and how it might start flying regularly over that part of the globe.

But even in developed nations with widespread internet access, there has been interest in what Loon's unique approach could provide. Cassidy recently traveled to a meeting with Japanese officials in Tokyo. "One of the great benefits of being in the stratosphere is that it's above the weather," says Cassidy, when I ask him about the potential for flights over more of the developed world. "If there is a hurricane or a typhoon that knocks out power or internet connectivity to people on the ground, the balloons provide very exciting ways to allow people to have immediate connectivity. As long as they have a battery powered phone in their pocket, people will be able to instantly get access to the balloon network."



"FLOATING CELL TOWERS IN THE SKY."

Last year, Project Loon switched its payloads from Wi-Fi to LTE — "floating cell towers in the sky," Cassidy calls them — which led to big improvements in speed and reliability.

For connectivity the balloons link up with base stations and pass signal between themselves like relay runners exchanging a baton. The move to LTE has also given a big boost to the business model, because it's now a turnkey solution for wireless network operators. "The main reason the telcos are so excited about partnering with us is that they want to reach all the people in their country," says Cassidy. In fact, in many cases there is a government mandate for universal access — but building out wireline networks, cell towers, and fiber optics to remote rural regions isn't cost effective. "Flying a balloon overhead, on the other hand, can be done very cheaply."

The team recently crossed another milestone with its first successful connection test across multiple continents. Balloons launched in New Zealand flew over 9,000 kilometers (about 5,600 miles) to Latin America and delivered an internet connection, then flew back around the globe for another successful connection test in Australia, navigating the balloons within 500 meters of their target locations at opposite ends of the world.

GOOGLE WANTS TO WORK WITH, NOT AGAINST, THE INCUMBENT TELCOS

Loon has now conducted tests with Vodafone in New Zealand, Telstra in Australia, and Telefonica in Latin America, and it says it's working on commercial deals with several new network operators around the globe. These companies already own the spectrum and have the infrastructure in place to market, sell, and bill customers for service. Google gets permission to use the spectrum and provides the cell towers in the sky, sharing the revenue for each new customer with the telco.

"Sometimes people think of Google X as a research lab. But it's not just that," says Cassidy. "Very early on in the project analysis it has to have a viable business model, and they are tough on the business model."

As Cassidy speaks, his voice rises with excitement, and you can recognize the former startup savant coming to the fore. "Think about it — with 4.5 billion people without internet access, take 5 percent; you're talking 250 million people," he says. If those people pay just a small portion of their monthly income, say \$5 a piece, "you're going to be in a billion dollars a month in revenue, tens of billions a year in revenue. So it's good business, too."



Loon's Pamela Desrochers inspects the inside of a popped balloon for damage.

Back at Moffett, the sun is setting, casting long shadows through the enormous bay doors. High up in the rafters, I've got my camera trained on the Loons below, hoping to catch the moment they explode. But I miss: with a silent slump, the balloon below me rents open and starts to crumple on itself. A small cheer goes up from the engineering team, who clamber inside through the tears to access the damage and see what they can improve for next time.

IT'S SOMETHING THAT'S NEVER BEEN ASKED OF BALLOONS BEFORE

Pamela Desrochers, a former fashion designer turned Loon program manager, is inside the carcass. She has obsessed over every detail of how to make the Loons last longer, from the materials to the special socks manufacturing workers now have to wear when walking on them. In this hangar, Loon staff are hyper-focused on finding better construction techniques, but it's clear that Loon is just a piece of a much grander puzzle

— a puzzle that now involves balloons, satellites, fiber, and terrestrial wireless. Google, like Facebook, is looking to provide internet access so that its services can reach every corner of the globe, no matter how remote.

Desrochers emerges from the tattered side of the slowly deflating balloon. She's been studying the way the fabric twists and folds to try and prevent the next pop. "This is something that has never been asked of balloons before, to be reliable, to do what we ask them to do," she remarks. "Before it was just a vehicle to gain knowledge. Now we're trying to make a business."

Subscribe to The Verge on YouTube for more great videos

Directed by Jordan Oplinger

Edited by Jimmy Shelton

Motion Graphics by Philip Robibero

Produced by Tre Shallowhorn

Shot by Weston Reel and Jordan Oplinger

Audio Mixing by John Lagomarsino

Correction: The pressure measurements at Moffett were read in pascals, not PSI. The text has been updated accordingly. We apologize for the error.